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The American Biology Teacher

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The American Biology Teacher

Vol. 10 DECEMBER, 1948 No. 8

From the A. A. A. S.

Mr. President, members of the AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, Ladies and Gentlemen:

I am deeply honored in being with you tonight on the one hundredth anniversary of the founding of the American Association for the Advancement of Science. As President of the United States, I welcome you to Washington.

In the one hundred years since this Association was organized, science has helped transform the United States into the most productive Nation in the world. I know that in your meetings this week you will be looking back over the progress of American science in the past century. I also know that you are much more interested in looking into the future.

You are looking forward, I know, because we stand at this moment at the threshold of revolutionary developments. Scientific research daily becomes more important to our agriculture, our industry, and our health. The members of this Association know better than I what developments to expect in the years ahead in physics, in chemistry, in biology and the other sciences, but I am certain of this—that science will change our lives in the century ahead even more than it has changed them in the hundred years just past.

I hope you will also be thinking about the relationship between science and our national policy.

Two years ago, I appointed a Scientific Research Board. Its report, entitled *Science and Public Policy*, was submitted last fall. The report stressed the importance of science to our national welfare, and it contained a number of important recommendations.

The most important were these:

First, we should double our total public and private allocations of funds to the sciences. We are now devoting, through Federal and private expenditure, little more than one billion dollars for research and development per year. With a national income of more than $200 billion annually, the Board felt that we should devote at least $2 billion to scientific research and development each year.

Excerpts from the Address of the President of the United States at the Opening Session of the Centennial Celebration of the American Association for the Advancement of Science, Monday Evening, September 13, 1948, Washington, D. C.

Second, greater emphasis should be placed on basic research and on medical research.

Third, a National Science Foundation should be established.

Fourth, more aid should be granted to the universities, both for student scholarships and for research facilities.

Fifth, the work of the research agencies of the Federal Government should be better financed and coordinated.

I hope that you have been weighing these recommendations carefully, and that if you agree with me that they are sound, you will consider how they can be made effective national policies. . . .

If we are to maintain the leadership in science that is essential to national strength, we must vigorously press ahead in research. There is one simple axiom on which this thought is based. The secrets of nature are not our monopoly. Any nation that is willing and able to make the effort can learn the secrets that we have learned. Such a nation may, indeed, discover new facts of nature we have not yet discovered.

Our problem, therefore, is not a static one of preserving what we have. Our problem is to continue to engage in pure —or fundamental—research in all scientific fields. Such research alone leads to striking developments that mean leadership. Yet it is precisely in this area that we, as a Nation, have been weakest. We have been strong in applied science and in technology, but in the past we have relied largely on Europe for basic knowledge. . . .

Some of the fundamental research necessary to our national interest is being understaken by the Federal Government. The Government has, I believe, two obligations in connection with this research if we are to obtain the results we hope for. First, it must provide truly adequate funds and facilities. Second, it must provide the working atmosphere in which research progress is possible.

As to the first point, the Government is developing impressive programs in many scientific fields. Fundamental research is being carried on for the *National Military Establishment* in the laboratories of the armed forces, of industry, and of our universities. The *Atomic Energy Commission* has been pushing its extensive research. The *National Advisory Committee for Aeronautics* has expanded its many aeronautical developments. The Federal Security Agency has engaged in extensive medical studies, in its own laboratories like the *National Institute of Health*, and through grants to colleges and universities. Other Federal agencies, such as the Departments of Commerce, of Agriculture, and of the Interior, have pursued vigorous programs. The *Inter-Departmental Committee on Scientific Research and Development*, appointed by me last March, aids in coordinating the Government's many research programs. I sincerely hope that these programs will be further developed and coordinated by the early passage of a *National Science Foundation* bill.

The second obligation of the Federal Government in connection with basic research is to provide working conditions under which scientists will be encouraged to work for the Government. Scientists do not want to work in ivory towers, but they do want to work in an atmosphere free from suspicion, personal insult, or politically motivated attacks. It is highly unfortunate that we have not been able to maintain the proper conditions for best scientific work. This failure has grave implications for our national security and welfare. . . .

Continuous research by our best scientists is the key to American scientific

leadership and true national security. This indispensable work may be made impossible by the creation of an atmosphere in which no man feels safe against the public airing of unfounded rumors, gossip and vilification. Such an atmosphere is un-American. It is the climate of a totalitarian country in which scientists are expected to change their theories to match changes in the police state's propaganda line. . . .

We are only in the beginnings of the atomic age. The knowledge that we now have is but a fraction of the knowledge we must get, whether for peaceful uses or for national defense. We must depend on intensive research to acquire the further knowledge we need. We cannot drive scientists into our laboratories, but, if we tolerate reckless or unfair attacks, we can certainly drive them out.

These are truths that every scientist knows. They are truths that the American people need to understand.

Science has no political affiliation. Concern for our national security is nonpartisan. Sober recognition of scientific research as the basis of our future national security should certainly be nonpartisan. All Americans have a solemn obligation to avoid those methods and procedures which are impeding scientific research—whether adopted mistakenly with good intent, or advocated in the name of security by men with other axes to grind. . . .

Now and in the years ahead, we need more than anything else the honest and uncompromising common-sense of science. Science means a method of thought. That method is characterized by open-mindedness, honesty, perseverence, and, above all, by an unflinching passion for knowledge and truth. When more of the peoples of the world have learned the ways of thought of the scientist, we shall have better reason to expect lasting peace and a fuller life for all.

A Statement on the Relationships of the Voluntary Health Agencies to the School Health Program

Several groups either legally or through common interest share in the school health program. The growth of the program and of the health knowledge upon which it is based is almost staggering. Only through the effective relationship of all groups with important contributions to make can the school health program approach its goal, the best possible health for all children now and throughout their lives.

School authorities by law carry the ultimate responsibility of all programs conducted in the schools. This includes the school health program. Since the control of communicable disease is a part of every school program and is frequently by law the responsibility of the public health department, and since in some states departments of health are responsible by law for medical examinations and follow-up, the latter to the extent set by local statute shares the responsibility of the school health program.

There are many groups without legal

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responsibility for the school health program which nevertheless have a vital interest in and contribution to make, in whole or in part, to the school health program. Important among these are the medical and dental professions which have through the years given impetus and sound advice toward the continued improvement of school health programs.

Another essential group is the voluntary agency composed of interested citizens, both lay and professional. These agencies are frequently concerned with some special aspect of health. This interest, if properly placed and properly handled, has a part in the total school health program. The aim of the voluntary health agency interested in the school age child is to help make possible for boys and girls lives of usefulness unhampered by illness or poor health. The effectiveness of the voluntary health agency's assistance to schools depends to a large degree upon the mutual understanding of the responsibilities, limitations, and contributions peculiar to each.

A. Guiding Principles

1. School authorities have the legal responsibility for all school programs. The unique function of the school is education.
2. Voluntary health agencies accept this. They also recognize that school age is an excellent learning age. Moreover, their money comes from the community with the trust that it be spent to the best advantage. For these three reasons they strive, logically, to have what they consider important learning material included in this age period. School administrators should recognize that voluntary health agencies have the responsibility and the right to offer and to urge the use of their services. Voluntary health agencies should recognize that the school authorities have the choice of accepting or refusing these services. A cooperative attitude on the part of both parties leads to the most effective use of the services offered.
3. It is very desirable that personnel working with the schools in any phase of education for health be acquainted with the problems of school administration and classroom instruction and should have an understanding of acceptable policies and practices in health education.
4. While voluntary health agencies may contribute to any part of the school health program their most valuable services are usually in the field of health instruction.
5. All efforts in the health instruction of children in school must be channeled through the regularly constituted educational authorities, in cooperation with any other agencies which may also be concerned. This should apply to any situation whether on the Federal, State, or local level.
6. The voluntary health agency should never attempt to superimpose a fixed plan on any individual school system, or part of the system, but should work with school personnel for the desired goal.
7. Health education materials offered by voluntary health agencies for the elementary grades must be in harmony with the mental and emotional stage of development of the children concerned. Only those public health problems which touch the child's daily health practices such as the use of quarantine in the control of communicable diseases in children come within his range of interest and understanding. Learning experiences which have direct bearing on his personal health are basically important for these grades. The child in these years is interested in health, not disease.
8. In the secondary schools education related to special diseases or special health problems should be integrated

into the health course and into such general courses as human biology and general science. It is not acceptable educational practice that programs dealing with specific health problems such as nutrition, cancer, tuberculosis, venereal disease, and first aid be set up as a separate or extra subject. So isolated, one aspect of health has little or no chance of assuming its proper place in the individual's total health learning.

9. The voluntary agency must have a clear understanding with the educational authorities as to suitability and distribution to school personnel of materials they provide. Sound educational policy involves mutual agreement that the provision of educational materials to schools by voluntary agencies by kept separate from their direct fund-raising campaigns.
10. The voluntary health agency should be familiar with the extent and quality of the teachers' education in health.

B. Types of Aid Acceptable

1. Up to date, accurate information on the agency's special health interests. Such assistance should be not only welcomed but asked for by school personnel, who cannot expect to be able to keep up with all phases of the rapidly increasing health knowledge.
2. Teaching tools, as pamphlets, posters, charts, graphs, films, film strips and slides, exhibits. Such material must be accurate, clear in concept, attractive, and effective, with its purpose solely educational.
3. Suggested teaching units. It is recommended that in the preparation of teaching units the voluntary health agency make use of experienced teachers so that the material is adjusted properly to grade levels and needs.
4. Consultation services.
5. Personnel assigned to educational authorities to work under their jurisdiction.
6. Assistance in the formation of school health councils and coordination of the school health councils with the community health council.
7. Qualified personnel provided to demonstrate a health education program or part thereof, to experiment in new types of programs or to fill the temporary lack of adequate school personnel.
8. Cooperation in the in-service course in health education either in the form of funds or personnel. Such courses should be developed cooperatively with school authorities, especially those having to do with teacher preparation and certification.
9. Scholarships for education in health education.
10. Financial assistance and/or leadership in special projects, such as workshops.
11. Individual conferences with teachers possibly including demonstration teaching of selected health units by a qualified health educator.
12. Guidance in helping teachers to understand classroom observations and/or measurements, non-diagnostic or medical in nature and to be alert to detect, and refer children with signs of impaired health.
13. Guidance to teachers or parents in learning the use of non-medical, non-diagnostic screening tests, such as vision and hearing testing, and weighing and measuring.
14. Educational presentations to classroom groups, supplementary or summarizing in nature. These are not to take the place of classroom teaching, which is not to be provided by the voluntary agency except for possible demonstration teaching of a health lesson.
15. Parent health education.
16. Leadership in parent or teacher study groups.
17. Informing school administrators and teachers of general advances in health knowledge and practice.
18. Securing the interest and cooperation

of other community groups to participate in the school health program, e.g., conferences and medical and/or educational presentations for teacher groups.

19. Interpreting school health program and unmet needs to the community and stimulating action if desirable.

Approved by the School Health Section Council of the American Public Health Association, November, 1947.

IF YOU HAVE NOT renewed your membership, turn to page 201 and send the blank with the necessary remittance to the secretary-treasurer. Volume 11 starts with the January issue; this is the last number to be mailed to those who have not paid their dues for 1949.

The Radioautographic Method in Biology and Medicine

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For centuries the chemical elements have been objects of scientific investigation. In 1896 Henri Becquerel discovered that some of the heavier elements were naturally radioactive, emitting alpha, beta and gamma radiation. This emission was studied extensively during the subsequent years. One of the significant advances was the announcement of artificial radioactivity by Curie and Joliot in 1934. It was soon established that all of the known chemical elements possess varying numbers of isotopes, many of which are artificially radioactive, emitting alpha, beta and gamma particles and positrons. The disintegration process is unique, for only one type of emission is known for each radioactive isotope.

The radiations emitted by the isotopes may be detected with Geiger counters, spectrometers, ionization chambers or by photographic methods. In 1924 Lacassagne and Lattes reported a modification of the photographic method which has been widely used in biology and medicine. It is simply a method of contact photography for detecting and recording radiations from radioactive isotopes. The photographs obtained are usually called radioautographs but some workers prefer autoradiographs or simply autographs.

In the usual applications of this method a solution containing a radioactive isotope is administered to the specimen (or patient) under examination. After a suitable period of time has elapsed portions of the specimens are removed and sectioned. The sections are placed in direct contact with a photographic plate and the combination bound together. Those portions of the specimen containing the radioactive element emit radiations which affect the photographic emulsion in the same manner as ordinary visible light or X-rays. After the development of the photographic plate that region of the emulsion which was adjacent to the radioactive portion of the sample will be darkened. The type and extent of darkening is a measure of the concentration of the radioactive material in that portion of the sample in contact with the plate. The radioautographic technique localizes the sources of radiation more closely than any other method of detection now available.

Choice of Isotopes

For best results an isotope should be chosen which will be localized in the specimen, and which possesses a half-life long enough to permit satisfactory completion of the histological and photographic work. For most of the isotopes in common use, such as P-32, I-131 or Na-24, exposures of one or two half-lives are sufficient for good results.*

The isotope chosen for the photographic work should not be soluble in any of the solutions used in the histological procedure. For example, P-32 is soluble in acid fixing agents, hence acetone or alcohol should be used instead. Some workers prefer to freeze the tissue and keep it frozen during sectioning and photography. This prevents loss of soluble material, but requires thick sections and does not give precise localization.

* In this paper the radioactive isotopes are indicated by the symbol of the chemical element, followed by the mass number, i.e. P-32, Phosphorus with a mass number of 32.

Specimen Sections

For best results thin sections, 5–10 μ,* are used. These are placed in close contact with the film. A thicker section will give good results only if the isotope emits soft beta or alpha radiations.

The sections may be placed on paraffined paper, and then on the film, or may be placed directly on the emulsion and fastened with tape. In some cases a small press is used to hold the film and section in close contact. After exposure the section and plate are separated and the plate developed. For comparison with the radioautograph the sections may be stained in the usual manner.

* This symbol is used to denote a *micron*, which is one thousandth of a millimeter.

Photographic Plates

The disintegration process for the particular isotope chosen will determine the type of photographic plate to be used. Plates are available with emulsions sensitive to X-rays, to visible light, to particular particles or to spectra. For beta and gamma emitters ordinary X-ray film is sensitive enough, but the emulsion contains large and irregular grains. Many workers recommend Agfa no-screen X-ray film. The spectroscopic and particle plates are finer-grained, but are less sensitive. Lantern slide emulsions and dental X-ray films are also suitable.

Alpha emitters show up very clearly on the special particle plates, appearing as short, straight lines. In many cases it is possible to locate the origin of a particular particle. Beta particles have shorter ranges than gamma, and hence are more effective. The beta energies are dissipated within the film emulsion, but only a small percentage of the gamma are utilized in the emulsion.

In some experiments it is desirable to use some method of alignment of photographic plate and section so that the plate and section may be studied together under low magnification by first focusing on the tissue and then on the autograph. A reference mark on the plate is usually sufficient.

Exposure Time

The time of exposure required depends on the amount of radioactive isotope concentrated in the section. In plant experiments the exposures may be as short as one hour. 3 μ sections of thyroid containing I-131 of activity 0.3 microcuries per gram, must be exposed from 5 to 8 days for satisfactory autographs.

Typical Investigations

One of the earliest radioautographic studies was that of D. I. Arnon, P. Stout and F. Sipos (*Am. J. Botany*, 27, 791, 1940). They studied the distribution of P-32 in tomato plants growing in an aerated nutrient solution. The isotope was added as a phosphate, Na_2HPO_4, with maximum concentration of radioactive phosphorus 28.5 microcuries per liter of nutrient solution. Leaves and fruit were removed from the plants 36 hours after the introduction of the labeled phosphorus. Radioautographs of the leaves were made with and without sectioning. The samples were laid upon paraffined paper and placed over no-screen X-ray film. The combination was bound in black paper and pressed together with a heavy glass plate. Exposures of one hour gave a clear picture of the P-32 distribution. Samples of green and ripe fruit were sectioned, placed on paraffined paper, and then on the film. Over-night exposure was necessary for good results. The radioautographs showed that phosphorus is found in the stems and conduction system of the leaves. They showed that the phosphate moves upward with the transpiration stream. The green fruit contained the greatest concentration of phosphorus, especially in the seeds.

Another modification of the basic process is illustrated by the use of K-42 in radioautography of a rat's brain. The isotope was administered by intraperitoneal injection in the form of a 5.44% aqueous solution of the chloride, in doses equivalent to 0.75 millicuries per 100 grams of body weight. After a lapse of from 12 to 18 hours to allow the system to reach equilibrium the brain of the rat was removed. Slices 3 to 4 mm. thick were fixed in absolute alcohol, infiltered with a 50% xylene-50% paraffin mixture, blocked and sectioned. The sections, 6–12 μ in thickness, were fixed to microslides, and a small strip of dental X-ray film bound to each slide under pressure, and exposed from 12 to 14 hours. H. F. Colfer and E. E. Essex (*Proc. Soc. Exptl. Biol. & Med.* 63, 243, 1946) found that the K-42 was homogeneously distributed throughout the brain, with a slight concentration in the cerebral and cerebellar cortex.

An interesting point in this experiment is that the radioautographs were less distinct if the tissues were cleared of xylene and paraffin before binding to the film. Other workers, using different tissues, however, have obtained satisfactory results on removing the paraffin and xylene.

Limitations of the Method

Perhaps the chief limitation of the radioautographic technique is that it is essentially qualitative and not quantitative. The radioautographs show where the isotope is located, but not how it was transferred to its location, or in what form it exists in the location. One method of quantitation by means of microdensitometric measurements has been devised by D. J. Axelrod and J. G. Hamilton (*Am. J. Pathol.* 23, 389, 1947). This may have wide application.

Another limitation is that the range of resolution for radioautography is the same as that obtainable by ordinary photomicrography. The method, then, does not yield any structural results not already known.

Since the use of the atomic bomb much has been written on the effects of radiations from radioactive materials. Some of these dangers are associated with the useful isotopes of radioautography. The beta emitters are usually less dangerous because the glass containers serve as sufficient screens, but beta and

gamma emitters, such as I-131, should be handled with extension tongs and the material be kept shielded. The same precautions which are required in our nuclear laboratories should be utilized with the isotopes. This means that not only must proper care be taken by the experimenter, but that the dosage of tissue must be kept below tolerance limits for radiation damage.

Applications

The method described here offers a wide field for investigation by the student of biology or medicine. The techniques are not difficult to master. Frequent consultations with departments of physics or radiology are desirable to insure safety. Until the radioactive materials are available in simpler forms and certain of the hazards eliminated, it is not recommended that these projects be instituted in the high school laboratory.

The growing of plants in nutrient solutions has been well established on both a commercial and laboratory scale. There are many possible investigations similar to the P-32 work of Arnon, Stout and Sipos, using the different elements present in the various nutrient formulae. Since the method of hydroponics is applicable to a wide variety of plants, the radioautographic technique may be utilized in many different ways.

The field af invertebrates has been almost neglected in radioautographic studies. The distribution of the chemical elements in the bodies of the invertebrates, and the tracing of these elements during various stages of development, constitutes a vast project.

The isotopes for use in radioautographic experiments may be obtained through commercial supply houses, such as Tracerlab, or the Eastman Kodak Company, or through the Oak Ridge Laboratories. In each case a certificate of eligibility from the Atomic Energy Commission is required. This may be obtained quite readily by college departments.

A summary of the more significant results of radioautographic experiments is given below. It is impossible to include all of the results. Those cited have been selected to illustrate the use of a variety of isotopes.

Phosphorus—32

1. Upward movement of inorganic ions in cotton, willow and geranium. Experiments showed that the anions and cations of assimilated salts were transported to the aerial portions by the wood. P. Stout and J. R. Hoagland (*Am. J. Botany*, 26, 320, 1939).

2. Distribution of isotope in wax moth, mealworm, cockroach and firebrat. Autographs indicate that in the wax moth larva the radiophosphorus is found in the digestive tract, the silk glands and the ducts of the silk glands. In all four insect species the epithelium of the midintestine contained a large amount of the phosphorus. Most of the detectable phosphorus was in phosphoprotein combination, particularly in the newly formed tissues such as the gonads, gonoducts and wing buds. E. Lindsey and R. Craig (*Ann. Entomol. Soc. Am.*, 35, 50, 1942).

3. Deposition as phosphate in the skeletal structure. Rats were used as test animals. The P-32 was found not only in bone but in the bone marrow and soft tissue, such as liver. In the same experiment Sr-89 and Ca-45 were investigated. Both were found to be deposited almost completely in bone. The bones were placed directly on the film for the autographs. Rabbits and white mice were also used. C. Pecher (*Proc. Soc. Exptl. Biol. & Med.*, 46, 86, 1941).

4. Translocation studies using squash plants. Distribution and mode of distribution to the leaves, using aqueous Na_2HPO_4 containing labeled phosphorus. The tubules in the phloem were found to be the channels of distribution. The embryos of the seeds and interfascicular cambium in the stem were

regions of P-32 accumulation. R. N. Colwell (*Am. J. Botany,* 29, 798, 1942).

Iodine—131

1. Distribution in various kinds of normal thyroid and in cancerous thyroids. The isotope was administered orally as an aqueous solution of the sodium salt. Thyroidectomies were performed 48 to 55 hours after dosage. An almost uniform distribution of iodine throughout the normal thyroid was found. In a hyperplastic thyroid there was an accumulation of iodine in the undamaged colloid. Iodine was not deposited in cancerous tissue. J. G. Hamilton, M. H. Soley and K. B. Eichorn (*U. Cal. Pub. Pharmacol.,* I, 28, 339, 1940 and J. G. Hamilton, *J. Appl. Physics,* 12, 440, 1941).
2. Iodine metabolism in *Drosophila gibberosa.* B. M. Wheeler, (*Proc. Nat. Acad. Sci.* 33, 298, 1947).
3. Completion of thyroidectomy tests. Thyroidectomized rats were injected with 4 ml. sodium iodide, containing I-131, of dose activity 2 microcuries per ml. The regions of the trachea and esophagus bordering the thyroid were dissected out, and autographs made. Animals showing no visible thyroid tissue remaining showed the presence of unremoved tissue in the autographs. W. O. Reinhardt (*Proc. Soc. Exptl. Biol. & Med.,* 50, 81, 1942).

Sulfur—35

1. Distribution in wheat kernels. B. F. Harrison, M.D. Thomas and G. R. Hill (*Plant Physiol.* 19, 245, 1944).
2. Distribution in the skin of mustard gas containing labeled sulfur. Mustard gas was shown by radioautographs to penetrate the epidermis quickly, and accumulate in the hair follicles, sebaceous glands and walls of the blood vessels within the dermis. D. J. Axelrod and J. G. Hamilton (*Am. J. Pathol.* 23, 389, 1947).

Sodium—24

Location of radiosodium in *Nitella.* The protoplasm of *Nitella* was not harmed by the radioactive sodium provided the activity was under 1000 microcuries per liter. J. Mullins (*J. Cell. and Comp. Physiol.* 14, 403, 1939).

Zinc—55

Investigation of the concentration of radiozinc in tomato fruit and seeds. The seeds showed the greatest concentration. E. O. Lawrence (*Nuclear Physics and Biology,* Rutgers University Symposium, 1946).

Strontium—89

Deposition of radiostrontium in the skeletal structure. Following administration as a lactate the strontium accumulated in the neoplastic tissue and in the epiphyseal line where growth is proceeding. There was also some deposition in the callus. D. H. Copp and D. M. Greenberg (*J. Nutrition,* 29, 261, 1945).

Copper—64

Distribution of radiocopper in the chick embryo. E. Smith and P. Gray (*Anat. Record,* 99 (Suppl.), 52 (Abstr.), 1947).

Carbon—14

Existence in bone of this isotope of carbon in the form of a carbonate. W. Bloo, H. J. Curtis, F. C. McLean (*Science,* 105, 47, 1947).

THE WASHINGTON MEETING of 1948 will be reported as fully as possible in the columns of The American Biology Teacher; there are of course many features of a meeting that cannot be put on the printed page, and these can only be mentioned. But many of the papers will be printed in full and briefs or abstracts of the others will appear; reports of all official actions will be printed. The proof of the January issue must go to the printer too soon to permit much of the meeting to be reported in that number. Most of the "reporting" will be in the February number, and the March issue will feature as many as possible of the papers presented at the various program sessions.

The Five Best Remembered Plant Facts

CHARLES E. PACKARD
Randolph-Macon College, Ashland, Virginia

Autumn school weeks were speeding away as lesson plans called for a change of topic. During October we had been considering plant life. In our chemistry laboratory where biology classes were held pending the erection of a long-awaited new building with its enticing facilities for science projects and procedures, we had looked at many specimens gathered from garden and field.

About once every week or ten days, in order to show what we had talked over and read about in the chapters on the flowering plants as described in MOON AND MANN'S and CURTIS, CALDWELL, AND SHERMAN'S texts, I carried much actual material to class. It included leaves, stems to illustrate branching, bud types, root systems, flowers and their inflorescences, attractive fruits and vegetables such as a well-supplied, garden-conscious neighborhood, including my own productions at Victory Valley Farm, would afford.

The array was distributed on the chemistry locker unit tops with just enough space provided for the students in my large sections of forty and over to stand side by side and examine them. For the first time, I found, not a few learned facts they had scarcely realized before. How little, as well as how much, certain members knew of practical gardening was revealed by incidental remarks and comments. One girl had planted green snap beans in quart berry baskets early in the spring for summer transplanting. Whether she had her reward in a crop earlier than her neighbors I did not find. Everyone was victory gardening that year with illuminating experiences.

Textbooks figures and descriptions were compared with actualities, and records were encouraged by means of blackboard questions and outlines. The pupils enjoyed these exercises, made enquiries about the work as it went along, and showed excellent interest in spite of crowded quarters and other limitations.

At the close of the study, about November tenth, I wished to find out something concerning what the classes had remembered and what, if anything, had made the greatest impression. My proposal was intentionally planned as a surprise so that there might be no more than the usual review and preparation. The two classes, College Preparatory and General, followed each other for the sixth and seventh or final periods of the day. Little concern was shown when I assured them that this was in the nature of an exploration test not to be graded severely for marks of standing. They wrote willingly and interestedly on the topic "The Five Facts which I Remember Best about Plant Life."

There was little opportunity to see more than the flowering plants and their organs although some demonstrations with the compound microscope were arranged for observation. Text material on the spore-formers was not as plentiful as for the seed-bearers. Some time had been spent on economic values and certain plant functions had been presented with but a minimum of experimentation.

PLANT FACT TABULATION BY TOPICS AND IDEAS
College Preparatory Division (*40 Pupils*)

I. Plant Classification, Groupings	Flowering, flowerless	19
	Algae, fungi	11
	Dependent, independent	11
	Seed and spore-bearers	11
	Chlorophyll, non-chlorophyll bearers	2
	Flowerless Plant examples	10
	Relative importance flowering and flowerless	1
	Monocotyledons, dicotyledons	1
		66
II. Photosynthesis, Chlorophyll, Food-making	Raw materials, products	14
	Chlorophyll occurrence, general	9
	" importance, "	4
	" as food-maker	3
	" as green coloring matter	2
	Intake of CO_2, outgo of O_2	1
	Oxygen as products vital to animals	1
	Foods and materials through roots and leaves	1
		35
III. Pollination, Reproduction, Seed Dispersal	Pollination, modes	9
	Reproduction, "	5
	Self and cross-pollination	3
	Dispersal, modes	3
	Color attraction	2
	Gametic union	1
	Germination	1
	Fern spore formation	1
		25
IV. Flower Structure	Flower parts	9
	Completeness	4
	Petal number	2
	Perfect condition	1
		16
V. Broadly General	Plants helpful to man	8
	Mushrooms, care in use, nature of	3
	Reproduction as a plant process	2
	Plants as much alive as animals	1
		14
VI. Nutrition, Respiration, Growth, Life Duration	Fermentation change	7
	Parasitism	3
	Saprophytism	1
	Plant functions comparable to man's	1
	Growth Process	1
	CO_2 given off	1
	Annuals, biennials, perennials	3
		17
VII. Structure	Root Systems	3
	Fruit Types	2
	Plant Organs and Tissues	4
	Leaf Parts	1
		10

VIII. Bacteria	Types	3
	Uses	2
		5
IX. Fitness, Survival, Response	General	4
	Tropisms (Heliotropism, Geotropism)	2
		6
X. Unclassifiable	Grossly Incorrect	17
	Confused, not clearly stated	10
		27

Comments and Notations

In illustration of Group X two pupils said that in photosynthesis starch is changed to sugar. Two pupils listed 5 and 8 brief topics, not distinguishing between the same and statements of fact. One made no enumeration but wrote in essay form. One wrote an outline using as headings, photosynthesis, calyx, corolla, seed distribution, and kinds of fruits. One listed the topics of roots, stems, photosynthesis, fermentation, and geotropism, then made statements of fact about them. Three wrote partly in topical, partly in statement form.

Much effort was made throughout the teaching period to have terms used exactly and grammatically. It is interesting to note that three used the term "bacteria" with the verb "are", one used it with "is". Sixteen used the plurals "fungi" and "algae" with "are", four used them with "is".

Statement Summary by Number

Pupils	Statements
2	8
2	7
3	6
2	4
3	3
28	5

Statement Summary by Grading

Pupils	Grade
21	Very good
12	Good
6	Fair
1	Unacceptable

In a number of cases though the writer had listed the fact as only one, actually there were two ideas incorporated therefore a little duplication occurs and the main groupings include the extra thoughts expressed. Four simple diagrams appear in this division as illustrations of statements made.

General Course Students

Tabulation and analysis of data obtained from the General Course students proved to be a harder task. The facts chosen did not lend themselves, because of generality and indefiniteness, to easy classification and organization into topical form. Thoughts were not expressed clearly and were less specific—a result not at all unexpected for marked differences had already appeared to distinguish the groups. The teaching approach had been a little different, with less emphasis placed on exact informational data. Principles and practical applications had been kept in mind. The study amply supports the wisdom of sectioning according to abilities, future needs, and capacity for performance. The textbooks used were different although essentially the same ground was covered. There could not be too great departure from a common plan, therefore the following list of groups conforms largely to the classification of part one.

Comments and Notations

When errors were made in this group they were rather startling. One said "The green coloring in plants is the

PLANT FACT TABULATION BY TOPICS AND IDEAS
General Course Division (*42 Pupils*)

I. Plant Classification, Grouping	Flowering, flowerless	4
	Algae, fungi	6
	Dependent, independent	3
	Seed and spore-bearers	2
	Mono-, di-, and polycotyledons	3
	Annuals, perennials	4
		22
II. Photosynthesis, Chlorophyll, Food-making	Chlorophyll occurrence, general	10
	Food-making function	10
	Photosynthesis in green plants	7
	CO_2 intake	2
	Photosynthesis involving light	1
	The plant as a "scientist"	2
	" " " " factory	1
	Plant remaining green all year	1
	Color change in autumn	2
		36
III. Pollination, Reproduction, Fertilization, Seed Dispersal	Self and cross-fertilization	7
	Need for reproduction	1
	Fertilization	1
	Male, female flowers	1
	Need for pollination	1
	Seed Production	2
	Need for seed distribution	1
	Mode of dispersal	2
	Mosses and spore production	1
	Life continuation	1
		18
IV. Flower Structure	Flower parts listed	6
	Completeness	1
	Perfect condition	1
		8
V. Broadly General	Plants, helpful, harmful	6
	Mushrooms, precaution in use	7
	All plants reproduce	1
	Plants are alive	2
	Plants edible, inedible	2
	Edible fruits	1
	Plants needed by man	1
	Cycle of decay	1
	Ferns are plants	1
	Tiniest plants seen by microscope	1
	Habitat of plants in the ocean	1
	Different structures of plants	1
	Biology—the study of living things	1
	Growth	1
		27
VI. Nutrition	Sugar, starches as food	2
	Ferments	1
		3
VII. Structure	Root systems	2
	Fruits, kinds, numbers	1

	Plant organs, list	3
	Leaf in general	2
	Leaf similar to a house	1
	Fern rhizome	2
	Root location	1
	Vascular bundles	2
	Annual rings	1
		15
VIII. Bacteria, Fungi	Examples of fungi	4
	Small size	3
	Bacteria as plants	1
	Dependence, chlorophyll lack	4
	Large size of mushrooms	1
	Habitat	1
	Mycelium and hypha	1
	As parasites	1
		16
IX. Environment	Factors needed	13
	N replacement in soil	1
		14
X. Osmosis, Conduction	Moisture passage through cells	1
	Phloem conduction	5
	Soil water absorption	2
	Root uses	1
		9
XI. Miscellaneous	Ferns higher than liverworts-evolution	1
	Spermatophyte defined	1
	Plants used for fuel	1
	Plants in decorations	1
	Opposite leaf arrangement	1
	Sunflower a composite type	1
		6
XII. Unclassifiable	Grossly Incorrect	20
	Confused, not clearly stated	17
		37

xylon''; another that ''The spirogyra plants are ferns and mosses.'' Some examples of confused and mixed statements are:

''The environment depends upon their growth,'' ''All plants contain the process of photosynthesis,'' ''The raw materials of fermentation are ferments,'' ''The ovary is one of the divisions of the stigma,'' ''The anther is the pollen,'' ''The stigma is a group of organs,'' ''All green plants are algea and all fungi is absent of green color.''

Study of the chlorophyll-bearers had created the inpression that they were the only plant types, as witness the following:

''All plants are independent,'' ''All plants make their own food.''

The vascular plants made an impression on one who wrote ''All plants have a vascular system and a pith,'' and another ''All plants have roots and stems.'' One mis-stated the difference between annuals and perennials, reversing the situation.

Five in this group wrote topically, one of these only partly so, however. There were no diagrams. Six used ''fungi'' and ''algae'' with the correct verb form,

seven used them and "bacteria" incorrectly.

STATEMENT SUMMARY BY NUMBER

Pupils	Statements
1	10
2	7
2	6
8	4
1	3
2	2
27	5 (as required)

STATEMENT SUMMARY BY GRADING

Pupils	Grade
7	Very Good
14	Good
16	Fair
5	Poor and Unacceptable

In conclusion may it not be said that we teach, in part, that information may be gained and a generous percentage kept? Does a pattern of retention evolve which would hold for an entire group year in and year out? The wide variety of facts which these eighty–two youth recalled concerning plants indicates that there was considerable catholicity of interest. Yet some uniformity emerges.

An association had been made by contrast. Plants either were or were not, did or didn't, had or hadn't certain likeness, abilities, features. Nor was it wholly the facts that were seen which made an impression. Processes of food-making, reproduction and nutrition stand high in the listings along with anatomical characters, if they do not actually over-shadow them. The importance to the world of plant life was stressed as it was believed a subject otherwise of lesser appeal might gain attention from that approach. Once the role of photosynthesis and chlorophyll was visualized it was not lost from consciousness. And it is very likely that an appreciation and understanding of the place of plants in the world was, for these particular young people, somewhat enhanced.

BOOKS

MITCHELL, PHILIP H. *A Textbook of General Physiology.* 4th ed. McGraw-Hill Book Company, New York. 927 pp. illus. 1948. $7.50.

This rather detailed review of a well-known text will be welcomed by the many friends of the previous editions. The basic plan and the attitudes of the book remain as they were. It still builds up to and around human physiology as the central area of emphasis. The chemical foundation of physiology, both general and human, has been given an even larger place than before. The book starts with the fundamentals of life reactions and reacting systems, then treats the chemical and physical features of protoplasm and of organisms, follows with discussions of diffusion, osmosis and the changes depending largely on these, and finally, treats digestion, circulation and the other body functions. As in the previous editions reproduction has been omitted except for incidental mention here and there.

There are twenty-six chapters, which fit into each other so as to give the book unusual continuity without making actual references from one chapter to another. The illustrations and tables are carefully done and well selected. The index is comprehensive and so arranged that almost any topic or technical term is easy to find. The reference lists at the ends of the chapters are more extensive than is usual in a textbook. The paper, typography and arrangement make for ready reading. All in all, this is an excellent book for the high school or college teacher, the college student, and the unusually able or especially interested high school student. It should be available on the library shelves wherever biology is taught.

NESBIT, PAUL W. and JEWELL W. NESBIT. *Instructive Nature Games.* Published by the author, Estes Park, Colorado. 36 pp. illus. 1947. 75¢.

This little booklet consists of descriptions of a number of nature games and rules for playing them. In some cases these are given in much detail. The table of contents, which presents a good idea of the type and scope of the games, is as follows: Fetchit, Nature Nuts, Games Using Nature Characters, Treasure Hunts, Password, Games of Recognition, Games of Naming, True and False Commands, Cycles of Nature. Many of the games are illustrated by photographs or drawings. There is a short list of references.

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This is a ***fiddler crab.*** One claw is much larger than the other and looks like a violin, or "fiddle". The crab waves its large claw in the air as it walks.

Plant eelgrass, arrowhead, and other rooted plants so the ***crown*** is just above the sand. The crown is the place where the roots begin. Anchor the plants in place with small pebbles.

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A long-awaited series of discussional-type slidefilms for teaching under water life and for study has been added to its "Science Adventures" series by The Jam Handy Organization.

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RECENT PUBLICATIONS

ZANGERL, RAINER. *The Vertebrate Fauna of the Selma Formation of Alabama.* Chicago Natural History Museum, Chicago, Illinois. 56 pp. illus. 1948. $1.50.

A technical overview of the main fossil localities of the Selma formation and a detailed treatment of fossil turtles from the area. Unusual illustrations and data tables.

MARTIN, ALEXANDER C. *Botany and Our Social Economy.* National Wildlife Federation, Washington 10, D. C. 30 pp. illus. 1948.

Information on the plants as basic elements of our economy and a discussion of the difficulties encountered in restoration and most effective utilization.

BLOUGH, GLENN O. and PAUL E. BLACKWOOD. *Teaching Elementary Science.* United States Government Printing Office, Washington, D. C. 40 pp. illus. 1948.

A brief discussion of the scope of elementary science, how children learn science, best methods of teaching, available science teaching references, materials and apparatus, and a selected bibliography.

HALLOCK, GRACE T. *Tuberculosis, A Manual for Teachers.* National Tuberculosis Association, 1790 Broadway, New York 19, N. Y. 96 pp. illus. 1948.

Six chapters—The Problem of Tuberculosis, The Nature of Tuberculosis, Factors Influencing Resistance to Tuberculosis, The

Diagnosis, The Treatment, and The Control—an appendix consisting of references and notes, and an index. Many illustrations, tables and graphs.

Health Bulletin for Teachers, Volume XIX, No. 4, March, 1948. Metropolitan Life Insurance Company. 4 pp.

A brief summary of food needs, in terms of specific daily amounts, and a table of observable signs of poor nutritional status. Considers total food needs, including vitamins and minerals.

Medical Education in the United States and Canada. Reprinted from the Educational Number of the Journal of the American Medical Association, Vol. 137, pp. 25–75 (Sept. 4) 1948.

This is the 48th annual report on medical education in the United States and Canada. Includes a list of medical schools, internships and residencies, the examining boards in the medical specialties, and a great deal of other information useful to premedical advisors.

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